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PATENT

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re U.S. national phase of)	
PCT/IB2003/006162)	
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Inventor: Kiyohito MURATA)	
)	Examiner: Not Yet Assigned
Application No.: Not Yet Assigned)	
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Filed: June 27, 2005)	
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For: EXHAUST HEAT POWER)	
GENERATION APPARATUS)	

Commissioner for Patents
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Sir:

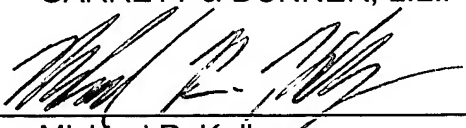
REQUEST FOR SUBSTITUTION OF REPLACEMENT SHEETS

Please substitute the attached (1) replacement pages 2, and 2A of the Article 34 Amendments for page 2 of the specification in the enclosed as-filed PCT application and (2) replacement pages 22 and 23 of the claims containing the Article 34 Amendments for pages 22, 23 and 24 of the claims in the enclosed as-filed PCT application. It is respectfully requested that the specification and claims in the substitute pages be examined during examination of the patent application.

Respectfully submitted,

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converting module and the exhaust pipe/cooling unit is interfered by the thermal expansion, the heat conduction therebetween is deteriorated, decreasing the thermoelectric conversion efficiency. Especially an outer pipe of a generally employed exhaust heat power generation apparatus, to which the exhaust pipe and the cooling units are attached, is formed of a single member. The above-formed outer pipe is hardly allowed to absorb the aforementioned distortion. As a result, the distortion extends over the apparatus. If the cooling unit is formed of a water cooling system with high rigidity, it may further be difficult to absorb the distortion owing to low spring constant.

Conventionally the outer pipe of the exhaust heat power generation apparatus, to which the exhaust pipe and the cooling unit are attached, is formed of the material exhibiting low thermal expansion ratio such as a stainless steel so as to reduce the thermal distortion. The stainless steel exhibits low thermal conductivity, and therefore, high heat resistance. As a result, the thermal energy is lost during passage through the members at the high temperature and the low temperature sides before it is transferred to the thermoelectric converting module. This may deteriorate the thermoelectric conversion efficiency.

JP-A-11-122960 discloses an exhaust heat generating device interposing buffer elements between the thermoelectric element and the cooling unit in order to absorb mechanical oscillation of the supporting members due to temperature changes. However, by interposing additional material between the thermoelectric element and the cooling unit the thermoelectric conversion is deteriorated.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an exhaust heat generation apparatus with excellent thermoelectric conversion efficiency.

An exhaust heat power generation apparatus includes a thermoelectric converting unit that converts thermal energy of exhaust gas into electric energy, a heat exchange unit provided on one surface of the thermoelectric converting unit to conduct the thermal energy of the exhaust gas that flows through an exhaust pipe, and a cooling unit provided on the other surface of the thermoelectric converting unit to cool the thermoelectric converting unit. The cooling unit has a rigidity set to a highest value among those of the thermoelectric converting unit, the heat exchange unit and the cooling unit.

The exhaust heat power generation apparatus includes a system in which the thermoelectric converting unit is interposed between the heat exchange unit that conducts the thermal energy of the exhaust gas flowing through the exhaust pipe and the cooling unit such that the thermal energy is transferred. In the aforementioned
5 system, the cooling unit has the highest rigidity. This makes it possible to allow the cooling unit to apply appropriate surface pressure to the thermoelectric converting

CLAIMS:

1. An exhaust heat power generation apparatus comprising:
a thermoelectric converting unit that converts thermal energy of
exhaust gas into electric energy;
5 a heat exchange unit provided on one surface of the thermoelectric
converting unit to conduct the thermal energy of the exhaust gas that flows through an
exhaust pipe; and
a cooling unit provided on the other surface of the thermoelectric
converting unit to cool the thermoelectric converting unit, wherein the cooling unit
10 has a rigidity set to a highest value among those of the thermoelectric converting unit,
the heat exchange unit and the cooling unit.
2. The exhaust heat power generation apparatus according to claim 1,
wherein:
the heat exchange unit includes a heat exchange fin for conducting the
15 thermal energy of the exhaust gas and a base having one surface on which the heat
exchange unit is placed, and the other surface on which the thermoelectric converting
unit is placed;
the exhaust pipe includes a main body that forms a frame of an exhaust
passage to which the base is attached, and the heat exchange fin provided therein;
20 the exhaust passage is constructed by the exhaust pipe and the heat
exchange unit; and
the base has a rigidity set to a highest value in a structure of the
exhaust passage.
3. The exhaust heat power generation apparatus according to claim 2,
25 wherein the main body of the exhaust pipe is formed of a material exhibiting a
thermal expansion ratio lower than that of the heat exchange unit.
4. The exhaust heat power generation apparatus according to claim 3,
wherein the main body of the exhaust pipe is formed of a stainless steel.
5. The exhaust heat power generation apparatus according to claim 2 or 3,
30 wherein:
the main body of the exhaust pipe is provided in a center of the exhaust
heat power generation apparatus, the thermoelectric converting unit is provided on an
outer periphery of the heat exchange unit attached to the main body of the exhaust
pipe, and the cooling unit is provided on an outer periphery of the thermoelectric

converting unit;

an elastic member is provided on an outer side of the cooling unit; and

an elastic system for fixing the thermoelectric converting unit is

formed, in which a pressure is applied to the cooling unit externally by the elastic

5 member.

6. The exhaust heat power generation apparatus according to claim 5,
wherein:

the thermoelectric converting unit includes a module formed of a
plurality of thermoelectric elements; and

10 a unit of the elastic system is structured based on the module.

7. The exhaust heat power generation apparatus according to claim 5 or 6,
wherein the elastic member includes a spring and a compression member which are
one of in point contact and line contact with each other.

8. The exhaust heat power generation apparatus according to claim 2,
15 wherein the heat exchange fin in the exhaust pipe has different pitches among fins
thereof.

9. The exhaust heat power generation apparatus according to claim 8,
wherein the heat exchange fin is formed of a material partially exhibiting different
heat conductivities.

20 10. The exhaust heat power generation apparatus according to claim 2 or 7,
wherein each of the heat exchange unit and the main body of the exhaust pipe has a
configuration such that a direction in which the base of the heat exchange unit
deforms becomes opposite to a direction in which a contacting surface of the main
body of the exhaust pipe deforms, the contacting surface contacting the base of the
25 heat exchange unit.